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BIOLOGY AND PARASITOLOGY OF EUROPEAN BEAVER (*CASTOR FIBER* L. 1758) – SELECTED ISSUES

WYBRANE ZAGADNIENIA Z BIOLOGII I PARAZYTOLOGII BOBRA EUROPEJSKIEGO (*CASTOR FIBER* L. 1758)

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Streszczenie. Bobry uznawane są za największe spośród gryzoni zamieszkujących Europę i Amerykę Północną. W rodzinie bobrowatych, wyróżniono dwa gatunki – bobra europejskiego (*Castor fiber*, L.1758) oraz bobra kanadyjskiego (*Castor canadensis*, Kuhl 1820). W czasach starożytnych i średniowiecznych bobry europejskie występowały na terenie całej Europy oraz w części Azji, jednak w wyniku polowań od IX wieku populacja tych zwierząt stopniowo zaczęła się zmniejszać. Pod koniec XIX wieku w Europie zostały tylko nieliczne populacje tego zwierzęcia. W pojałtańskich granicach Polski odnotowano zaledwie 130 osobników bobra europejskiego. Ośrodki naukowe rozpoczęły wdrażanie programów środowiskowych mających na celu czynną ochronę gatunku. Dzięki tym działaniom liczebność populacji bobra sukcesywnie wzrasta. Obecnie bobry znów zajmują większą część zajmowanego wcześniej obszaru, a nawet rejony, w których nie występowały wcześniej. Występują na terenie całego kraju; liczebność szacowana jest na ponad 89 tysięcy. W pracy przedstawiono budowę ciała bobrów oraz ich fizjologię pozwalającą na prowadzenie lądowo-wodnego trybu życia. Opisano bazę pokarmową, budowę przewodu pokarmowego oraz proces trawienia. Przedstawiono i omówiono zagadnienia związane z rozrodem i wychowaniem młodych. Wymieniono naturalnych drapieżników tego gatunku. Opisano najczęściej występujące pasożyty zewnętrzne i wewnętrzne oraz na podstawie literatury podano również skalę inwazji.

Key words: beaver, biology, parasites.

Słowa kluczowe: bóbr, biologia, pasożyty.

INTRODUCTION

Rodents are wide animal group living wildly in various ecosystems all over the world. They makes one think of little species hiding in vegetations. One of most interesting and biggest rodent living in Europe are beavers. Currently beavers are legally protected as some time

ago they were close to extinct (Batbold et al. 2008). This help amount of beavers increase regularly and significantly (Żukowski and Kasperczyk 1988; Dijkstra 1999) with wide spread out in many ecosystems. Their ability and eagerness to build hydro-constructions e.g. dams or lodges related to cutting off surrounding trees is well known and observed in regions of their existence (Żurowski 1992). The former activity is often considered economical problem for human as it collides with selected human desired actions (Virbickas et al. 2015; Hägglund and Sjöberg 1999). However, considered ecologically beavers engineering and building actions are beneficial for regions they live, being its ecologically important element.

Adult beavers mainly due to leaving close to natural waters protecting them from predators are not subject of many natural external enemies. On the other hand, internal organisms e.g. parasites might be harmful for beavers.

EUROPEAN BEAVER – SELECTED BIOLOGICAL ISSUES

Beavers are claimed to be the biggest rodents leaving in Europe and North America. The beavers biological family that consists of beavers only, two species are included: European beaver (*Castor fiber*, L.1758) and Canadian beaver (*Castor Canadensis*, Kuhl 1820).

The European beaver body mass ranges from 18 to 20 kg, while length is between 75 to 100 cm (Wilsson 1971; Żurowski and Kasperczyk 1986). The beaver fur that is soft, dense and shining consist of hair types: down and covering. Specific structure of covering hair that is conical shape (wide at the ends and narrow at the base) stops water during diving at the fluff layer which in turn allows thermal isolation. The color of hair cover is different ranging from black through brown to white blond (Rosell and Pedersen 1999) – Fig. 1.

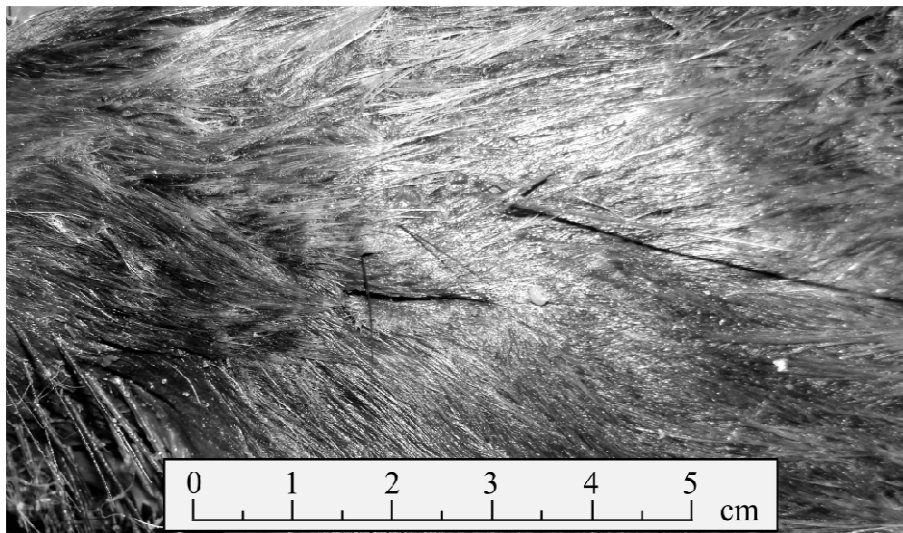


Fig. 1. Head of a beaver, view from the left side
Ryc. 1. Głowa bobra, widok lewego boku

The breast limbs are short, prehensile, while back limbs are strong and equipped with five fingers joined with film buoyant (Fig. 2).

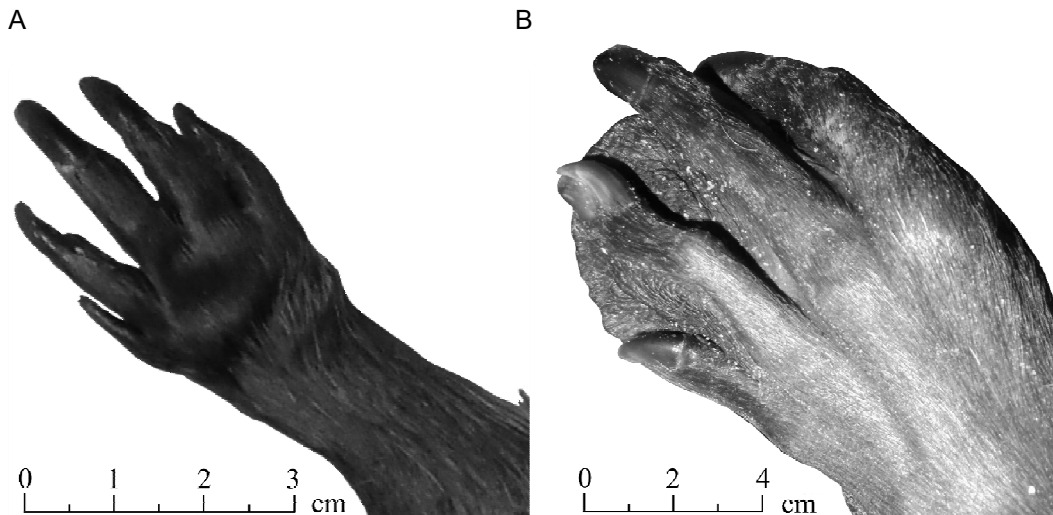


Fig. 2. View of the dorsal surface of a beaver: A) thoracic limb, B) pelvic limb
 Ryc. 2. Widok bobra od strony grzbietowej: A) kończyna piersiowa, B) kończyna miedniczna

This feature as well as big flatten tail (length around 20–25 cm) allows easy movement in water (Fig. 3).

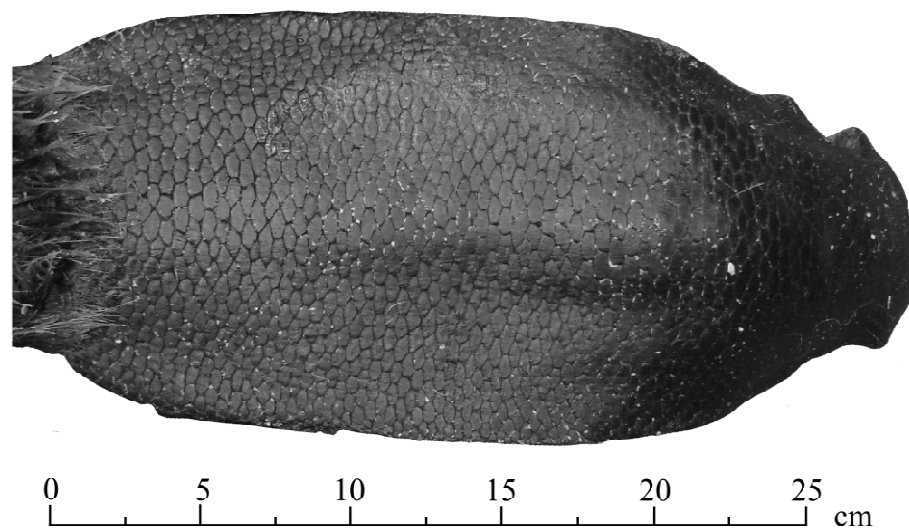


Fig. 3. Tail of a beaver, the view from the ventral surface
 Ryc. 3. Ogon bobra, widok od strony brzusznej

Moreover beavers are equipped in many other features allowing existence in water. Specific outside auricles, nostrils and eyes located high in the head allow observation of surrounding without necessity to significant surfacing of water level. The eyes are protected with third eyelid, auricles and nostrils are covered by skin fold during swimming. Beside features allowing swimming beavers are also physiologically equipped with mechanisms allowing underwater activity. They can stay up to 900 seconds underwater. This is due to increased level of mioglobin in skeletal muscles and slowed heart action during diving. There is not gender dimorphism in beavers (Vaughan et al. 2000; Czech 2010).

OCCURRENCE

According to Halley and Rosell (Halley and Rosell 2002), beavers (*Castor fiber*) were primary widely distributed all over Europe territory and part of Asia, although due to extensive hunting they were almost extinct with critical number of 1200 specimens in the XIX century. Currently beavers cover previously occupied territory with some extinct to regions they have not existed before since thousands years (Halley et al. 2012). Beavers' regions stretch from Iberian Peninsula through Middle Europe up to Scandinavian Peninsula and Ural (Halley et al. 2012).

Beaver live all over Poland with constantly increasing population number (Czech 2007). In 50th of XX century number of beavers was estimated to 130 specimen, in 1977 it was around 1000 while in 1994 it increased to 7600 animals. Count in year 2014 proved 14 000 specimens. (Borowski et al. 2005). Currently beavers' number in Poland is approximately 96 500. They are still partially protected in Poland (DzU 2011, no. 237).

Beavers live land-water life, using rivers, in-land water containers, as well as watercourses, irrigation ditches. Although they prefer forest lands they can occur in fields or even urbanized regions (Tattersall 1999). They most favorite environment is deciduous forest. Significant limit to feed access can force beavers to move away, however it is not only reason to live they current territory (Lahti and Helminen 1974).

According to Czech (2010), most part of beavers live in the regions up to 800 over sea level, however in 2015 they occurrence over 1000 meters over sea level has been reported (Strączek-Helios 2015).

BEAVERS' EFFECT ON NATURAL ENVIRONMENT

Beavers influence significantly environment they live Kukuła et al. (2008) reported irrigation effect of beavers activity. Some meadows and peat bogs dried due to melioration, while beavers action altering water retention recovered those regions.

Beavers constructions lead to biodiversity increase due to formation of new standing water containers that are preferred by invertebrates (Kukuła et al. 2008). Physic-chemical properties of water streams with living-in beavers change. Current decreases and average temperature increases. Mineral and organic sediments are stopped which in turn increase amount of animal available organic substance in water. The pH increase, level of oxygen varies (Czech 2010).

Although the effect of beavers action on environment is beneficial rather, its effect on human economy might be adverse. Borowski et al. (2005) explain that in some cases e.g. valuable types of trees natural monuments, trees plantations protection from beavers should be considered. Trees protection with use of tasty materials is not effective and does not bring expected results (Borowski et al. 2005), while flavored chemicals seems to be better. Rosell and Czech (1999) observed positive effects to scare beavers away with use of deterrents made of otter excrement. However, the deterrent smell is not beneficial if beavers are not experienced with given predator in any way (Rosell and Czech 1999).

FEEDING

Herbivorous beavers menu consists of number of green plants (over 200 species) and trees (over 100 species). Beavers prey close to water containers being a hideout in the case of danger (Lahti and Helminen 1974; Czech 2010).

Rodents consume mainly green plants and mares in spring, summer and early autumn. Majority of the feed are: Yellow Water-lily (*Nuphar luteum*), water horsetail (*Equisetum fluviatile*), Bog Arum (*Calla palustris*), White Water-lily (*Nyphaea alba*), and Carex (*Carex sp.*) (Lahti and Helminen 1974; Czech 2010).

Late autumn and in the winter beavers consume feed, that is bushes and deciduous trees, stored in their burrows. Most favorable are aspen (*Populus tremula*), birch (*Betula sp.*), willow (*Salix sp.*) and rowan (*Sorbus aucuparia*) (Lahti and Helminen 1974; Czech 2010). Beavers eat lifts, shoots, little branches, bark and fiber but wood (Vaughan et al. 2000; Czech 2010).

Ziółkowska et al. (2014) described beavers stomach in details. It remains C letter with the length ranging from 28 to 40 cm and circumference ranging from 22 to 30 cm. Circumference of stomach pylorus is usually between 15 and 18 cm.

Similarly to another mammalians, initial protein hydrolysis occurs in stomach with further processes of degradation and absorption of proteins, easy-to-digest fats and carbohydrates occur in small intestine. Undigested part of feed that consist of cellulose mainly, moves to big intestine. Bacteria located there assist in fermentation processes of structural carbohydrates (fiber).

The process of coprophagia occurs in beavers digestive system to better use valuable components e.g. vitamins, proteins occurring in undigested matter. Although twice digestion 30% of cellulose is digested in total (Kosieradzka 2012). Extremes eats directly from iners is known as cekotrof, that is soft and mucous. Final feces is hard and dry (Czech 2010; Kosieradzka 2012; Ziółkowska 2014). Similar strategy is observed in lagomorpha, that swallow mucous cekotrofs unlike beavers who chewing this type of faces (Baker and Hill 2003).

REPRODUCTION

Reproduction process usually starts in January and lasts until end of March. Copulation occurs under water – male dive under female with stomach up. The pregnancy period lasts 105–107 days. The average number of Young is 2 (Czech 2010). New-born beavers have fur and can see, although eyes are covered by mucous and half-open. Mothers milks only feed during first month of life. It contains 15% of fat and 8% of protein. Young beavers grow quickly, starting with 0.5 kg of initial body mass reaching 8–13 kg in the very first year. After two months young start to consume adults feed. In the same time they change daily activity from day to night (Czech 2010).

Beaver live about 30 years with significantly higher reproduction activity between 2.5 and 10th year. Critical for beavers are first days after delivery, period of feed type changing (from milk into solid state feed), and travels to find a partner.

There are some natural beaver's enemy: bears, foxes, wolfs, lynxes and nyctereutes. Young can be a victim of smaller predators e.g. otters or minks (Czech 2010). However the most dangerous beaver enemy is human.

BIOTIC ENVIRONMENTAL FACTORS RESPONSIBLE FOR PARASITE FAUNA IN BEAVERS

Parasites are natural part of life of widely living animals. Beavers are not exceptions, according to Kadulski (1998) 13 types of arthropods can be identified on beavers skin. The most common are acari (*Acari*) order *Sarcoptiformes*: *Schizocarpus numerosus*, *S. latus*, *S. minor*, *S. brachyurus*.

In smaller amount *S. mingaudi*, *S. parvus*, *S. subparvus*, *S. capitis* oraz *S. fedjushini* are present as well. Parasites are located in different parts of beavers body depend on the type. Beside listed above parasites two types of ticks are present on beavers bodies: *Ixodes hexagonus* (majority), *Ixodes apronophorus* (minority). Beetle *Platypyllus castoris* can also be found in beavers fur (Kadulski 1998; Czech 2010).

Beside outside parasites inside species are present in host (beaver) body. Most common are trematoda (*Stichorchis subtriquetrus*) and nematode (*Travassosius rufus*) (Demaszkiwicz et al. 2014). Nematode were detected for the very first time in Polish beavers in year 2000 (Drózd et al. 2000). *S. subtriquetrus* exist mainly in big intestine, exceptionally in blind intestine. Sometimes they are present in small intestine very rarely, e.g. single individuals, in stomach (Máca et al. 2015). According to Demaszkiwicz et al. (2014) Trematodas are most common parasites occurring in tested beavers. Within reference group consisted of 48 selected beavers including 13 young and 35 adults, 94% were infected with *S. subtriquetrus*. The parasite occurred quite significantly in young beavers (84.6% specimens were infected), moreover average number of trematoda was significantly higher than in the case of adults (201 and 93 parasites, respectively). Next within stomach *T. rufus* occurs significantly. According to Demaszkiwicz et al. (2014), 67% of beavers are infected with those parasites. The animal age is related to number and frequency of this nematode. 23% of young beavers were infected with average number equal to 362 nematodes, while between adult beavers 85.7% were infected with average 867 pieces per beaver.

Both parasites contribute to inflammation (Demaszkiwicz et al. 2014). Massive invasions of trematoda *S. subtriquetrus* bring about long term disease with vomiting, diarrhea, weakness, constipation, weight loss and anemia. Rodents become slow, and object for predators. Location of parasites is characterized with swelling, and infiltration of histiocytes, lymphocytes, eosinophiles, and neutrophiles. Those locations become an „open gate” for bacterial infections. Both parasites express seasonal activity with 100%, 93.7% and 87.5% in autumn, spring and summer, respectively. Average intensity of infection *S. subtriquetrus* is 222, 73 and 51 specimen in autumn, spring and summer, respectively (Demaszkiwicz et al. 2014). Authors explain this phenomena by infections during vegetative period. In the case of nematodes *T. rufus* seasonal dependence is reversed, that means in the autumn 43.7% specimens are infected with average number of 533 parasites, while during spring 87.5% specimens are infected with 893 specimens on average. Authors stress that this dependence is specific for *Trichostrongylidae* family only. Another parasites to settle in young beaver small intestine is *Psiloterma castoris*. This parasite is not as frequent as formerly discussed. Adult beavers small intestine can be location for *Trichostrongylus capricola* nematodes. Presence of larva form of *Echinococcus granulosus* was stated as well. *Ibidem* parasites do not exist in beavers blood.

Protozoa *Giardia* and *Cryptosporidium* are known to exist within beavers body. Constantly increasing number of infected beavers makes increasing reservoir for those species (Paziewska et al. 2007).

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Abstract. Beavers are known as biggest rodents leaving in Europe and North America. Two species are included in beaver family: european beaver (*Castor fiber*, L.1758) and candian beaver (*Castor canadensis*, Kuhl 1820). In ancient times beavers existed in whole Europe and in the part of Asia, while their population in Europe decreased systematically from IX century on due to extensive hunts. Consequently, in the end of XIX century only few beavers groups existed in Europe. Within after second world war Poland numerically 130 specimens of European beaver were present. Since then on active protection of this species has started including many environmental programs. It resulted in systematic increase of beaver specimens. Currently beavers came back to their previous regions and some new regions are occupied as well. Their amount reaches over 89000 specimens. This manuscript presents detailed structure of beavers body and their physiology allowing to leave in both water and on land. Beavers natural feed, digestive track, digestive process are described as well. Issues related to reproduction and bringing up are described too. Natural predators are presented. Inside and outside parasites with their action are presented.